

# Monetary and Fiscal Policy Interaction: The Consequences of Joining a Monetary Union.

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The great experiment in monetary unification across Europe is just beginning to provide the data needed to test the theories and debates surrounding the costs and benefits of forming a union. This paper will explore one particular aspect of the unification process, the effect it had on monetary and fiscal strategic interaction. Using a panel structural VAR to measure monetary and fiscal policy interaction among EMU members before and after joining the EMU, a difference in this interaction is detected. Pre-EMU the monetary and fiscal authority acted as strategic substitutes in the case of a monetary response to a fiscal receipts shock (such as a discretionary increase in taxes). After the formation of the union this relationship disappears and there is no strategic interaction. The timing of the change suggests a role for the Maastricht treaty coupled with the weak SGP.

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# **Monetary and Fiscal Policy Interaction: The Consequences of Joining a Monetary Union.**

## **1. Introduction**

The great experiment in monetary unification across Europe is just beginning to provide the data needed to test the theories and debates surrounding the costs and benefits of forming a union. Studying the actual costs and benefits of a monetary union the size of the EMU will help deter or accelerate the expansion of the current EMU, as well as the possible formation of other monetary unions across the world. At the very least the EMU experience provides information on how countries who do decide to form a monetary union can prepare for the issues that arise.

This paper will explore one particular aspect of the unification process, the effect it had on monetary and fiscal strategic interaction. The process and effects of monetary policy (to a greater extent) and fiscal policy (to a lesser extent) on macroeconomic variables such as output and inflation have been extensively studied.<sup>1</sup> The characteristics of the interaction between these policy makers, however, have received less attention in general and even less in relation to the monetary union (Muscatelli, Tirelli, and Trecroci, 2004). Policy makers interact as strategic substitutes when one policy maker's decision to conduct expansionary (contractionary) policy is met with contractionary (expansionary) policy by the other. For example, if the monetary authority were to raise interest rates the fiscal authority would respond by either increasing spending or lowering taxes. If they act as strategic complements expansionary policy by one authority is met with expansionary policy by the other and vice versa.

There are features specific to monetary unions as well as the European Monetary Union (EMU)

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<sup>1</sup> See Christiano, Eichenbaum, and Even (1999) for a summary of monetary policy empirical research and Caldara and Kamps (2008) for a summary of fiscal policy empirical research.

that suggest the relationship between monetary and fiscal authorities may change as a result of becoming a member. One salient feature of becoming a member of a monetary union is the loss of the ability to conduct independent monetary policy. The fiscal and monetary authority previous to joining the union function within the same national boundaries, interacting one with another in response to common economic fluctuations. After the formation of the union (in the absence of a central fiscal authority, as is the case in the EMU), the fiscal authority maintains its focus on the country specific needs while the monetary authority reacts to aggregate economic fluctuations. The greater “distance” not only in terms of physicality but purpose as well, could fundamentally change the way in which policy makers strategically interact.

In the case of the EMU it is also important to take into account the external restrictions placed on the conduct of monetary and fiscal policy in the run up to the creation of the monetary union and beyond. In order to insure that countries met the optimal currency criteria as introduced by Mundell (1961), potential members were required to meet certain convergence criteria. These were spelled out in the Maastricht Treaty signed in 1992. Members were to maintain exchange rates within a specified band, bring inflation to within 1.5 percentage points of the lowest inflation members, bring nominal long-term interest rates to within 2 percentage points of the low inflation countries, and bring budget deficits to within 3 percent of GDP and the national debt to 60 percent of GDP (Afxentiou, 2000). Meeting these criteria restricted the conduct of stabilizing fiscal policy for most members as they almost all had to reduce their budget deficits. It also forced monetary authorities of many potential members to concentrate primarily on inflation reduction, as many members had to lower inflation in order to meet the criteria. These restrictions and the role each policy maker played in order to meet the criteria could change the nature of interaction between policy makers (Leith and Wren-Lewis, 2000). The deficit restrictions were maintained under the Stability and Growth Pact (SGP) after the formation of the union and continue to restrict the conduct of fiscal policy if a member finds itself near the threshold in times of

economic trouble. The SGP has turned out to be less effective in restricting deficits, as a number of members violated the deficit threshold within the first five years of the union. As a result, the effects of fiscal restriction on interaction may be less so post-EMU.

Structural VARs using short run restriction are used to estimate monetary and fiscal interaction and compare them over the process of monetary unification in Europe. The estimation reveals that monetary and fiscal interaction did change after the advent of the monetary union in terms of how monetary authorities respond to revenue policy conducted by the government. Pre-EMU the policy makers acted as strategic substitutes while after the formation of the union there is no significant interaction. Though the causes of this observation are not fully explored, the results suggest the Maastricht convergence criteria played an important role.

In Section two theoretical and empirical studies of monetary and fiscal interaction are reviewed. In Section three the empirical model used to estimate monetary and fiscal interaction in Europe is introduced and estimated. Section four finishes with a discussion of the results as well as needed extension.

## **2. Monetary and Fiscal strategic interaction**

### **2.1 Theoretical**

The creation of the EMU led to a number of studies that set out to model the potential difficulties associated with monetary and fiscal policy in a monetary union. Great attention was paid to modeling how fiscal restrictions under the SGP would affect this relationship. Governatori and Eijffinger (2004), and Buti, Roeger, and In't Veld (2001) use a game theoretic approaches to analyze how the strategic relationship between independent fiscal authorities and a common monetary authority. Governatroi and Eijffinger (2004) illustrate the free rider problem that exists in fiscal policy conducted in a monetary

union. They show how the SGP does help to internalize the negative effects of deficit spillovers but the restriction is not enough to trigger the first best equilibrium of no deficits, no output gap, and stable inflation. Buti, Roeger, and In't Veld (2001) model the circumstances leading to fiscal coordination among monetary members. They find that substitutability and complementarity between policies depends on the type of shock hitting the economy. When fiscal authorities do not coordinate the central bank prefers high fiscal stabilization in the face of demand shocks and low in the face of supply shocks. Gains to co-operation are low when dealing with demand shocks but higher when there are supply shocks. They also show that expansionary fiscal policy leads to monetary tightening in this one country case.

Model simulations are also used to discuss interaction between monetary and fiscal policy makers in a monetary union. Leith and Wren-Lewis (2000) simulate a perpetual-youth model of a member of a monetary union to address the usefulness of budgetary restriction in a monetary union. They find that when the fiscal authority is constrained to stabilize its debt, the monetary authority is free to conduct its policy. On the other hand, if the fiscal authority is not self-stabilizing the monetary authority may have to reduce real interest rates when there is excess inflation. This finding justifies fiscal rules, though they do note that the SGP is more stringent than is needed. Van Aarle, Gerretsen, and Huart (2004) look at the effects on having different monetary and fiscal rules in the EMU. They use simulations from a calibrated two country New Neoclassical New Keynesian dynamic model. The model consists of an IS curve for each country as well as a hybrid Phillips curve for each country. There is one central bank which follows a Taylor rule while the fiscal authorities follow individual "fiscal Taylor rules". In their model of members of a monetary union they find strategic substitution. If there is a supply shock the monetary authority increases interest rates while the fiscal authorities of each country conduct expansionary policy to close the output gap. In the case of demand shock the monetary authority and each fiscal authority work together. In response to a country specific fiscal shock, say a reduction in the

deficit, a neighboring country must increase its deficit to combat the spillover effects that come as a result of trade. In this case however the common monetary authority helps in that it conducts expansionary policy in response the original country's restrictive policy.

Their simulation of a two country model suggests that in response to a monetary shock deficits will increase; the policy makers act as strategic substitutes. The two authorities also act as strategic substitutes in the face of a fiscal shock.

Advanced DSGE models have also been created that allow for strategic interaction between monetary and fiscal authorities. Benigno and Woodford (2003) demonstrate that a dynamic macro-foundations model can be constructed that allows for both the monetary and fiscal authority to respond optimally to fluctuations in the economy. Their results indicate that the monetary and fiscal authority should take into account how the actions they perform influence the goals of the other policy maker. Gali and Monacelli (2005) created a monetary union DSGE model where monetary and fiscal authorities both choosing their policy optimally. They show that under optimal policy, inflation is stabilized at the union level but there remains a stabilization role for fiscal policy. Fiscal stabilization is desirable not only for the individual country but the union as a whole if it is coordinated among members. When there is no fiscal coordination the policy makers' actions lead to a suboptimal outcome, where the common central bank faces a trade-off between inflation and output gap stabilization at the union level.

## **2.2 Empirical**

The interaction between monetary and fiscal authorities has been empirically measured in a number of different ways. Most studies estimate fiscal response functions that include a measure of monetary policy. Melitz (1997) estimated a pooled data set of 19 OECD countries (including 14 EU members) and finds that monetary and fiscal policy makers act as strategic substitutes. In response to a monetary tightening, fiscal policy would expand or not tighten as much as the monetary tightening. Von Hagen,

Hughes Hallet, and Strauch (2000) use a panel of 20 OECD countries from 1973 to 1989 to study fiscal consolidations. They find that when monetary policy is relaxed fiscal policy responds as a strategic substitute, but when fiscal policy is tightened the monetary authority responds as a strategic complement. When they limit the sample to European countries they do find a 'Maastricht effect', where in the 1990s fiscal policy becomes less reactive to monetary policy than before (as well as to cyclical fluctuations).

Gali and Perotti (2003) and the IMF (2004) estimate fiscal reaction functions for the EMU members using two stage least squares for individual countries as well as panel data. Gali and Perotti use data from 1980 to 2002 while the IMF uses data from 1971 to 2004. Both find that in general EU members' fiscal and monetary policy makers have acted as substitutes, though the magnitude is small. Both studies attempt to estimate changes to this relationship as a result of joining the union using dummy variables. They find that though there is no statistical difference in the reactions pre- and post-EMU in their small sample the response is smaller post-EMU. Claey's (2006) also estimates a fiscal reaction function with an instrumental variable GMM approach. He uses seven EU countries and finds significant strategic substitution only in Germany for data up to 2003, though he does suggest that a monetary union could lead to greater fiscal activism. There is no attempt to estimate differences as a result of joining the union however.

Estimation of single equation fiscal reaction functions do provide information and while instruments do take into account the endogeneity of the output gap, there is still the possibility of simultaneous equation bias. Every variable of interest is determined by the other. A single equation representation of a fiscal rule alone does not allow for a simultaneous measure of how monetary policy may strategically react to fiscal disturbances, nor would the estimation of a monetary rule allow for a measure of fiscal reaction to monetary movements.

Favero (2002) begins to address this issue using seemingly unrelated regression. In his estimation however there is no direct measure of strategic interaction between the fiscal and monetary authorities. Structural VARs (SVAR), as will be explained below, are well suited for this type of problem as long as the structural shocks can be confidently identified. Using SVARs allow for the inclusion of both monetary and fiscal policies, and thus measure strategic interaction between policy makers. There are a number of competing methods in using SVARs to identify fiscal shocks and thus monetary reactions to them. This paper will follow Fatas and Mihov's (2001) recursive approach coupled with Blanchard and Perotti's (2002) identification approach which takes into account automatic stabilizers.

Other methods of fiscal and monetary shock identification use SVARs, such as Mountford and Uhlig (2005) who use sign restrictions to identify structural shocks. Ramey and Shapiro (1998) introduce an events method, essentially identifying fiscal shocks in US history and using those points in time as dummy to model fiscal shocks. Caldara and Kamps (2008) compare and contrast each of these estimation techniques using US data. They find that even though there are some differences across models in how wages and consumption respond to fiscal shocks, they are all consistent in predicting strategic policy interaction for the US. Monetary policy makers do not respond to spending shocks, but the act as strategic substitutes in the case of a tax shock.<sup>2</sup>

The narrative approach is limited in its use because it requires a list of significant spending and taxing shocks and such a list has not yet been compiled for the European nations. The use of sign restrictions have received less attention and seems to provide little advantage over other methods in regards to the question at hand. This paper thus will use a recursive SVAR to measure monetary and fiscal reactions using pre- and post-EMU data. Impulse response functions are then estimated and

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<sup>2</sup> The narrative (events) approach did not allow for a measure of how monetary policy reacts to a tax shock as Ramey and Shapiro (1998) only identify spending shocks in United States historical data.



compared pre- and post-EMU using a Wald test. Any significant differences would indicate a change in strategic behavior between monetary and fiscal authorities as a result of joining the monetary union.

### 3. Testing the Nature of Responses

#### 3.1 Estimation Techniques

In order to examine monetary and fiscal interaction, their respective reaction functions need to be estimated. It is assumed that fiscal and monetary authorities respond to inflation and output fluctuations, yet their actions are not independent. For example a dynamic fiscal spending ( $s$ ) reaction function could include output ( $y$ ), inflation ( $\pi$ ), government receipts ( $r$ ), or the monetary reaction ( $i$ ), as well as its own lag and the lags of the other variables:

$$s_t = \beta_{12}^0 r_t + \beta_{13}^0 y_t + \beta_{14}^0 \pi_t + \beta_{15}^0 i_t + \beta_{11}^1 s_{t-1} + \beta_{12}^1 r_{t-1} + \beta_{13}^1 y_{t-1} + \beta_{14}^1 \pi_{t-1} + \beta_{15}^1 i_{t-1} + \dots + v_t^s$$

Yet receipts also respond to spending, output, inflation, the interest rate, and its lag as well as the lags of the other variables:

$$r_t = \beta_{21}^0 s_t + \beta_{23}^0 y_t + \beta_{24}^0 \pi_t + \beta_{25}^0 i_t + \beta_{22}^1 r_{t-1} + \beta_{21}^1 s_{t-1} + \beta_{23}^1 y_{t-1} + \beta_{24}^1 \pi_{t-1} + \beta_{25}^1 i_{t-1} + \dots + v_t^r$$

The monetary response would react to the same variables as well. In addition, output and inflation would be influenced by fiscal and monetary movements. Thus an OLS estimation of each of these relationships independent of one another would be biased because of simultaneity. Using VAR these relationships can be estimated as a system. Restrictions on the errors of the reduced form VAR allow for consistent estimates of the structural parameters of the model, specifically the structural error terms. Thus the SVAR (a reduced form VAR with identifying restrictions imposed) can be used to identify structural fiscal and monetary shocks and the reaction to them by the other variables in the VAR. The simultaneous system of equations can be collected and written in vector form as:

$$\mathbf{B}_0 \mathbf{Y}_t = \mathbf{B}_1 \mathbf{Y}_{t-1} + \mathbf{B}_2 \mathbf{Y}_{t-2} + \dots + \mathbf{v}_t$$

where ( $\mathbf{Y}$ ) is a vector containing government spending, government receipts, output, inflation, and the interest rate. ( $\mathbf{B}_j$ ) is a coefficient matrix and ( $\mathbf{v}$ ) is a vector of structural error terms. The reduced form VAR can be obtained by pre-multiplying by  $\mathbf{B}_0^{-1}$ .

$$\mathbf{Y}_t = \Phi_1 \mathbf{Y}_{t-1} + \Phi_2 \mathbf{Y}_{t-2} + \dots + \mathbf{u}_t$$

$\Phi_j = \mathbf{B}_0^{-1} \mathbf{B}_j$  and  $\mathbf{u} = \mathbf{B}_0^{-1} \mathbf{v}$ . The reduced form parameters can be estimated equation by equation using OLS, but this will not provide an estimation of the structural parameters. Identification of the structural parameters and shocks requires that the unknown parameters in the  $\mathbf{B}_0$  matrix have no more unknown parameters than distinct values in the covariance matrix. Because of the symmetry of the covariance matrix, there are only 15 free parameters for the  $(5 \times 5)$   $\mathbf{B}_0$  matrix. This means that 10 restrictions must be placed on the  $\mathbf{B}_0$  matrix in order to identify the structural shocks. The timing and response to fiscal and monetary policy provide these restrictions.

In the established literature on monetary shock identification, the important assumption is that monetary authorities are able to contemporaneously react to changes in the economy. On the other hand, monetary policy has a delayed effect on the economy, such that output and inflation react to the announced policy with a lag. The use of quarterly data in the SVAR is assumed to be short enough so that the reaction to monetary policy by the other variables in the system is zero in the first period. These assumptions provide four of the ten needed restrictions.<sup>3</sup>

Identification of discretionary fiscal policy shocks relies on the assumption that fiscal authorities react to economic fluctuations but are unable to do so contemporaneously because of the time

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<sup>3</sup> See Chistiano, Eichenbaum, and Evans (1999) for a good summary of the literature on monetary shock identification.

necessary to draft and approve changes to spending or taxes. Fatas and Mihov (2001) use a recursive approach to identify fiscal shocks. Blanchard and Perotti (2002) extend this work of fiscal shock identification by using timing restrictions in a SVAR while taking into account automatic stabilizers. Perotti (2002) and Canzoneri, Cumby, and Diba (2002) have expanded on Blanchard and Perotti's technique by including monetary policy as well as a number of other variables.

Fatas and Mihov as well as Blanchard and Perotti, use government spending and tax revenue (net of transfers) as arguments in their SVAR. These series respond within the quarter to movements in output through both automatic stabilizers and discretionary fiscal policy. Blanchard and Perotti remove the cyclical component from the reduced form residuals using outside estimations of the output elasticity of government spending and tax revenue found in Giorno, Richardson, Roseveare, and van der Noord (1995). Perotti (2002) expands the VAR to include inflation and monetary interaction, in which case he also estimates and uses the inflation elasticity of government spending and tax revenue. These estimations allow them to construct a cyclically adjusted government spending and tax revenue residual and provide two more restrictions on the SVAR. It is also assumed that government spending and receipts do affect output, inflation, and monetary policy within a quarter but are unable to respond to output, inflation, and the interest rate within one quarter because of the legislative inside lag. It is also assumed that spending does not respond within the quarter to changes in output. They take an agnostic stance on whether taxes affect spending, or spending effects taxes within the quarter, yet to get the final needed identification restriction receipts are assumed to not respond to spending within the quarter, while spending does respond to receipts.<sup>4</sup> These assumptions provide the remaining four restrictions needed to identify the structural parameters. As a result the relationship between structural disturbances ( $v_t$ ) and the reduced form disturbances ( $u_t$ ) is represented by:

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<sup>4</sup> This ordering assumption is reversed and found to not cause any significant change in the results.

$$\begin{aligned}
u_t^s &= \hat{\alpha}_{s\pi} u_t^\pi + v_t^s \\
u_t^r &= \hat{\alpha}_{ry} u_t^y + \hat{\alpha}_{r\pi} u_t^\pi + \beta_{rs} v_t^s + v_t^r \\
u_t^y &= \alpha_{ys} u_t^s + \alpha_{yr} u_t^r + v_t^y \\
u_t^\pi &= \alpha_{\pi s} u_t^s + \alpha_{\pi r} u_t^r + \alpha_{\pi y} u_t^y + v_t^\pi \\
u_t^i &= \alpha_{is} u_t^s + \alpha_{ir} u_t^r + \alpha_{iy} u_t^y + \alpha_{i\pi} u_t^\pi + v_t^i
\end{aligned}$$

Where  $(\alpha_{ry})$  is the output elasticity of government receipts,  $(\alpha_{\pi r})$  is the inflation elasticity of government receipts, and  $(\alpha_{s\pi})$  is the inflation elasticity of government spending. Each of these would be estimated or assumed before running the VAR.

This approach however has limitations for the purposes of this paper. We are interested in the change in monetary interaction pre- and post-EMU the data post-EMU, yet there are too few data to estimate each country individually. Panel VAR estimation is necessary in order to collect a sufficient sample post-EMU. The Blanchard and Perotti approach requires different measures of output and inflation elasticities for each country. Panel estimation would only allow for a common elasticity across the countries included in the estimation. The use of individual country cyclically adjusted spending and receipts data in the VAR overcomes this problem.

The use of cyclically adjusted spending and receipts slightly alters the identification scheme used by Perotti (2005). Instead of adjusting for automatic stabilizers in the residual, cyclically adjusted measures of government spending and taxes are used in the original SVAR. These values come from the OECD Economic Outlook database and are calculated using the same output elasticity of government spending and taxes from Giorno et al that Blanchard and Perotti use. They are constructed to remove the cyclical component (those portions that contemporaneously respond to output fluctuations i.e. automatic stabilizers) from the government accounts.<sup>5</sup> The cyclically adjusted series can be seen as a

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<sup>5</sup> The use of cyclically adjusted variables does not account for inflation elasticity of government revenues and spending.

measure of discretionary policy. Under this ordering assumption, the monetary authority reacts contemporaneously to movements in spending, taxes, output, and inflation. On the other hand, each of these responds with a lag to a monetary shock. Fiscal policy, in the form of changes to cyclically adjusted tax or spending, does not respond contemporaneously to output, inflation, or the interest rate. Output and inflation, on the other hand, do respond contemporaneously to these fiscal variables.

As a result, the relationship between structural disturbances ( $v_t$ ) and the reduced form disturbances ( $u_t$ ) is represented by:

$$\begin{aligned} u_t^s &= v_t^s \\ u_t^r &= \alpha_{rs} u_t^s + v_t^r \\ u_t^y &= \alpha_{ys} u_t^s + \alpha_{yr} u_t^r + v_t^y \\ u_t^\pi &= \alpha_{\pi s} u_t^s + \alpha_{\pi r} u_t^r + \alpha_{\pi y} u_t^y + v_t^\pi \\ u_t^i &= \alpha_{is} u_t^s + \alpha_{ir} u_t^r + \alpha_{iy} u_t^y + \alpha_{i\pi} u_t^\pi + v_t^i \end{aligned}$$

These timing restrictions thus provide a  $\mathbf{B}_0$  matrix that is lower triangular and can be obtained from a Cholesky decomposition of the covariance matrix from the reduced form VAR as in Fatas and Mihov. The variables are ordered such that  $\mathbf{Y}_t = [s_t \ r_t \ y_t \ \pi_t \ i_t]$ . With no economic model to suggest which should be ordered first, inflation or output, their structural shocks are not directly identified. The Cholesky framework makes it possible to transform the reduced form residuals into structural shocks using available panel VAR estimation programs.

The panel VAR necessitates the use of this alternative identification technique, but comparisons to the Perotti approach show that the modifications change the results very little. Appendix A shows the impulse response functions for the United States using the two methods described above. The data are from 1970q1 to 2006q4 and were obtained from the OECD. For this estimation the Perotti identification scheme uses output and inflation elasticities taken from Caldara et al (2008). The method in which the data was prepared also follows Caldara and Kamps (2008).

The responses and significance of the responses are similar across the two estimation techniques. The point of biggest departure in terms of direction and significance is in the response of inflation to a spending shock. This is not as surprising as cyclically adjusted variables do not take into account the price elasticity of spending while Blanchard and Perotti do. In terms of precision, the Blanchard and Perotti approach does find slight significant responses in the initial period following a shock for a spending response to a receipt shock, an output response to a receipt shock, and an interest rate response to a receipt shock, where my method does not. Only in one case, a receipt response to a monetary shock, does my method provide a significant response where the Perotti approach did not and only by a small margin. In each of these cases the response is of similar shape and direction. In two cases, a receipt response to a spending shock and an output response to a spending shock, do the modes differ in estimated directions, but in both of these cases the response is insignificant. As my method appears to correctly identify the shape and direction of response in relation to the Perotti approach, yet is less precise, any significant impulse response functions should be taken seriously.

Again it is the need to estimate this VAR with a panel that lead to the use of alternative estimation strategy. The EMU has been in existence since 1999, allowing for only thirty-one post-EMU observations per country. For a five variable VAR this is an alarmingly small number of observations. The use of panel data requires that the underlying structure of the model is the same for each country in the panel. Cyclically adjusted variables allow for country differences in the way the economy naturally adjusts to economic fluctuations, before the panel is estimated. Yet even with this variation allowed, panel models still assume that all other features of the countries' responses are the same. This can be partially overcome by allowing fixed effects into the model. Unfortunately, the auto-regressive nature of the VAR means that usual fixed effects estimation, instrumental variable estimation with mean differencing, no longer provides an unbiased estimation. Arellano and Bover (1995) show how this problem can be overcome using a 'Helmert procedure', which removes only the forward mean of the

variables in the VAR. As a result, the lagged original variables are orthogonal to the transformed variable and can be used as instruments just as in the normal fixed effects estimation. These orthogonal relationships provide moment conditions from which the panel VAR can be estimated using GMM.<sup>6</sup>

The strategy used to identify changes in the response of the monetary and fiscal authority to each other and to macroeconomic fluctuations is to compare estimated impulse response functions pre- and post-EMU. Once the impulse response functions have been estimated, a Wald test is performed testing the differences in the impulse response functions up to three periods after the initial shock. The covariance matrix used in this Wald test is bootstrapped from 500 Monte Carlo simulations of the differences in impulse response functions pre- and post-EMU. The null hypothesis tested is that there is no difference up to three periods after the shocks pre- and post-EMU.

### **3.2 Data**

Proper identification of fiscal and monetary shocks, as well as estimation of the fiscal and monetary reaction functions and their impulse responses, requires data for government spending, government revenues, output, prices, and the interest rate. As explained above, proper identification of discretionary fiscal policy requires that quarterly data be used. Using quarterly data also increases the number of observations, which is critical in the relatively short estimation post-EMU. Quarterly government data is very difficult to come by outside of the United States. The IMF changed the way in which they collect government quarterly data in 2001, preventing comparisons of fiscal variables before and after this date (Wickens 2002). In 2007 the OECD Economic Outlook posted quarterly fiscal variables for Finland, France, Ireland, and the Netherlands. These four countries will be combined to form a panel

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<sup>6</sup> Love (2006) provides an example of this technique being used in firm level data. She has graciously provided the code for the estimation of the panel VAR (Love, 2001)

data series consisting of 444 observations, 128 of which are post-EMU (taking the start date of the EMU as 1999 quarter 1).

The government spending series is cyclically adjusted current government disbursements excluding interest payments, while revenue is cyclically adjusted current government receipts. The GDP deflator is used for the price series while the three month market rate is used for the interest rate series. The GDP, spending, and revenue series are transformed into real per capita terms using the GDP deflator and working age population. Government disbursements, receipts, and GDP are each logged. Inflation is defined as the log difference in the GDP deflator.

It is important that each series used in the VAR be stationary to obtain consistent estimates of the parameters and impulse response functions. Each of the panel series were tested for stationarity with Im, Pesaran, Shin (2003) tests for unit roots in a panel series (results posted in Appendix B). The test rejects the null hypothesis of non-stationarity for the inflation and short term interest rate series. The test indicates that in the case of logged GDP, spending, and revenue per capita we must fail to reject the null hypothesis. As a result the first difference of the logged GDP, disbursement, and receipt per capita are used in the VAR (all of which are stable according to the Im, Pesara, and Shin test). Close inspection of the interest rate series for each of these countries does show a pronounced downward trend. This is a product of the time period over which the sample covers. Oil shocks in the 1970s caused high inflation to which monetary authorities across Europe responded with tight monetary policy. Since that time rates have steadily fallen as inflation was brought under control, allowing for looser monetary policy. In addition, the Maastricht treaty required convergence to a lower interest rate in preparation for joining the union. Dicky-Fuller stationarity tests of the interest rate series for each country in this sample indicate that the series is not stationary. Therefore the interest rate series is also first



differenced for use in the VAR<sup>7</sup>. A lag length of two is used in the VAR.

### 3.3 Results

Impulse response functions estimated across the whole sample and are presented in Appendix C. In response to a positive monetary shock, output falls after a delay while there is no significant response by inflation. This is very similar to the impulse response functions estimated for the United States in Appendix A. In response to a positive shock to government receipts, such as a tax increase, output and inflation fall in the first period. Government spending shocks cause an initial increase in output and, in the only anomaly, an immediate fall in inflation.

Impulse response functions do show some interaction between policy makers. In response to a positive shock to government receipts, interest rates fall. This indicates strategic substitution by the monetary authority. This is the opposite of what was found for the United States. The interaction between the two fiscal instruments is deficit biased; spending shocks are met with increased government receipts, but the revenue increase is not as large as the original spending shock. There is one period in which there is a positive significant response by spending to an interest rate shock, again indicating strategic substitution.

To determine differences in the responses pre-and post-EMU the SVAR is estimated and impulse response functions are generated separately from 1980q1 to 1998q4 and from 1999q1 to 2006q4. In order to test for differences in the responses pre-and post-EMU the difference in the responses are tested with a Wald test. The null hypothesis is that there is no difference between impulse responses up to three quarters from the time of the shock pre-and post-EMU. The Wald test statistics for the relevant relationships are listed in Table 1.

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<sup>7</sup> The estimation has also been done using HP filtered data with very similar results. These are available on request.

Table 1: Wald test statistic for differences in impulse response functions pre- and post-EMU

|       |          | Response |          |       |           |               |
|-------|----------|----------|----------|-------|-----------|---------------|
|       |          | Spending | Receipts | GDP   | Inflation | Interest rate |
| Shock | Spending | --       | 12.848** | 5.262 | 14.224*** | 5.128         |
|       | Receipts | 0.235    | --       | 3.406 | 16.036*** | 20.873***     |
|       | Monetary | 5.042    | 4.940    | 1.548 | 1.414     | --            |

Values come from a Chi Squared distribution, critical values are associated with 3 degrees of freedom

$H_0$ : The difference between each point of the impulse response function up to 3 periods after the shock = 0

\*\* Significant at a 5% level of significance

\*\*\*Significant at a 1% level of significance

There is significant difference in the way receipts and inflation respond to spending shocks as well as how inflation and interest rates respond to receipt shocks. There is no significant difference in the way any variable responds to a monetary shock. The impulse response functions for those in which there was a significant difference are displayed in Appendix D. Receipt collections are not as strong following a spending shock post-EMU as they are pre-EMU. This is an indication of greater deficit bias post-EMU. The significant difference in how inflation responds to a spending shock still maintains the non-Keynesian effect pre- and post-EMU, it is just slightly stronger pre-EMU. The inflation response to an increase in receipts is negative both pre- and post-EMU, yet is stronger in the initial period after the shock post-EMU.

It is the interaction between monetary and fiscal authorities, however, of interest for this study. As presented in Appendix E, there is no measurable difference in the strategic response of fiscal authorities to a monetary shock. In the case of a spending response to a monetary shock, spending rises after the shock pre- and post-EMU but the increase is insignificant. Only when taking the sample as a whole is any significant response found, and then it is small. Though impulses indicate an opposite response of the monetary authority to the spending shock pre- and post-EMU, neither movement is significantly different than zero at a 95% confidence level. There is, however, a significant difference in

how the monetary authority responds to a receipt shock. Pre-EMU there is statistically significant strategic substitution. As receipts rise through a discretionary increase in taxes or some other revenue source designed to dampen economic activity, interest rates fall and in order to stimulate economic activity. Post-EMU there is no such interplay, the ECB does not respond strategically to tax changes.

This outcome could signify that as a result of joining a union any strategic interplay is lost. Before the monetary union monetary and fiscal authorities, though independent of each other, were working towards accomplishing national goals and were indirectly or directly in contact and communication with each other. After the union, however, the European Central Bank is much further removed from the fiscal authority and the individual countries needs. They respond to aggregate levels of data. Just as the ECB is unable to respond to individual member's asymmetric fluctuations, which are lost in the union aggregate, so too is the ECB unable to respond to individual fiscal movements. This greater "distance" as a result of joining the union could have caused the change in strategic interaction.

This finding could also be due to differences in the types of shocks hitting the economy pre- and post-EMU. Buti et al (2007) and Van Aarle et al (2004) find that the interaction between monetary and fiscal policies are shock dependent. Their models indicate that the gains to policy coordination in the presence of demand shocks are low, whereas supply shocks lead to greater coordination. The loss of strategic interaction detected in the data could therefore be a manifestation of fewer supply shocks or more demand shocks hitting the economy post-EMU. Though there is no structural reason that a monetary union would cause such a shift in the shock structure of the European economy, these estimation techniques cannot dismiss this as a possibility.

Yet another explanation of the change in the interaction between policy makers lies in the specific convergence criteria put in place in the run up to joining the monetary union. The Maastricht Treaty required not only stable exchange rates, but similarity in inflation and interest rates across potential members. In the case of many potential members this required a significant reduction in

inflation. In addition budget deficits were restricted, which by the time the country joined the EMU had to be within 3 percent of GDP. This particular restriction required significant deficit reductions for many of the potential members. The strategic substitution evident pre-EMU could be an indication of one authority softening the blow (in terms of output) of the others policy used to meet the Maastricht criteria. For example a large increase in interest rates to bring down inflation would be met with a reduction in taxes to mitigate the future output effects of the monetary retraction. On the other hand, an increase in taxes in order to reduce deficit levels could be met with a loosening of monetary policy in order to mitigate the output effects of increased taxes.

Though data is limited, the sample is split up into three periods: the pre Maastricht period (1980q1 – 1991q1), the Maastricht period (1990q1 - 1998q4), and the post Maastricht period (1999q1 - 2006q4).<sup>8</sup> The response of interest rates to revenue shocks are presented in Appendix F. Only during the Maastricht period is there significant strategic interaction. In contrast to von Hagen et al (2000), interaction is greater during the Maastricht period. Their study however did not measure monetary reactions to fiscal policy, which is where interaction is detected in this study. Direct causation is not rigorously explored in this particular study, but the findings do indicate that the convergence criteria did play an important role in strategic monetary and fiscal interaction among European countries.

#### **4. Conclusions and extensions**

Entering a monetary union potentially changes the structure and relationship among and within members of the union. The act of giving up a national currency, and the inherent control and

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<sup>8</sup> The Maastricht treaty was signed in 1992, but the first stage of the Delors recommendations were put in place in 1990. Thus 1990 signified the application of the Delors report which would inevitably lead to a monetary union. This is the period chosen to represent the start of the Maastricht period as it signifies the beginning of the unification in earnest and provides a maximum number of observations for the VAR.

individuality of that currency, in order to gain the supposed economic advantages of a common currency requires tremendous political will and the surrender of some economic independence. The effects of the great European monetary experiment are just beginning to be studied as data become available. This paper addresses one possible cost/benefit from joining a monetary union, the change in the relationship and strategic interaction of the monetary and fiscal authority.

This paper finds that in one particular case, the response of the monetary authority to a fiscal receipts shock, the formation of the EMU did lead to a different strategic reaction. Pre-EMU the monetary and fiscal authority in this particular combination acted as strategic substitutes; if taxes or other revenue sources were raised the local monetary authority would lower the interest rate. After the formation of the union this relationship disappears and there is no strategic interaction. The cause of this change is not addressed directly from this study, but one possible explanation is the “distance” a monetary union places between the new union-wide monetary authority and the individual member fiscal authority. The observation that the substitutability only occurs during the Maastricht period, however, suggests that this result is more a feature of the convergence criteria put in place in the run up to joining the EMU coupled with a weak SGP. In many cases significant inflation and/or deficit reduction measure were undertake in order to qualify, according to the Maastricht treaty, for membership in monetary union. Only during the Maastricht period is this strategic interaction detected. The strategic substitution indicates that monetary and fiscal authorities (through government receipts) worked together soften the blow if each other’s actions in order to join the union.

One remaining explanation comes from the nature of shocks that hit the economy. Theoretical models indicate that policy interaction is more prevalent in the case of supply shocks, while the gains to coordination are diminished in the face of demand shocks. If the nature of the shocks hitting the European economies changed over this period of time the interaction might of as well. If this were the cause of the change in policy interaction, one would expect less supply shocks or a greater prevalence of

demand shocks post-EMU. The techniques used in this study, however, do not allow for a measure of supply and demand shocks. Van Aarle, Garretsen, and Gobbin (2003) use long-run restrictions to identify both monetary and fiscal shocks as well as supply and demand shocks. Possible extensions using similar restrictions could help answer this question.

Because the Maastricht period, with its strict convergence criteria, was so successful in reducing deficits and inflation across the European nations it would seem that the strategic substitution would be helpful in such extreme times. Would EMU members profit from continued strategic interaction between policy makers once in the monetary union? This is also a question yet to be answered in the literature in general. Further work should include some way of measuring the costs and benefits of such strategic interaction.

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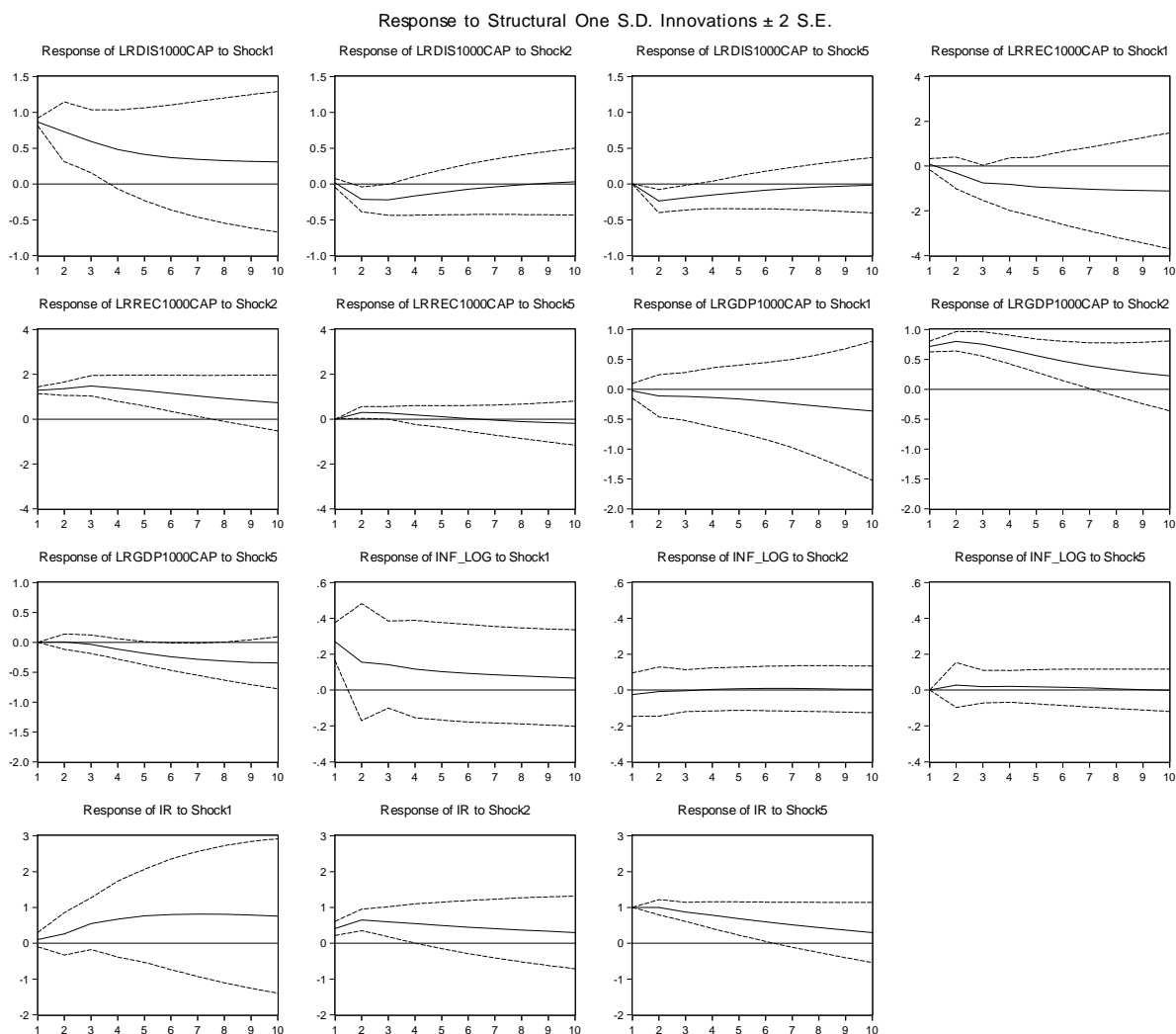
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## Appendix A

### Blanchard and Perroti Restrictions (BPR) – US data

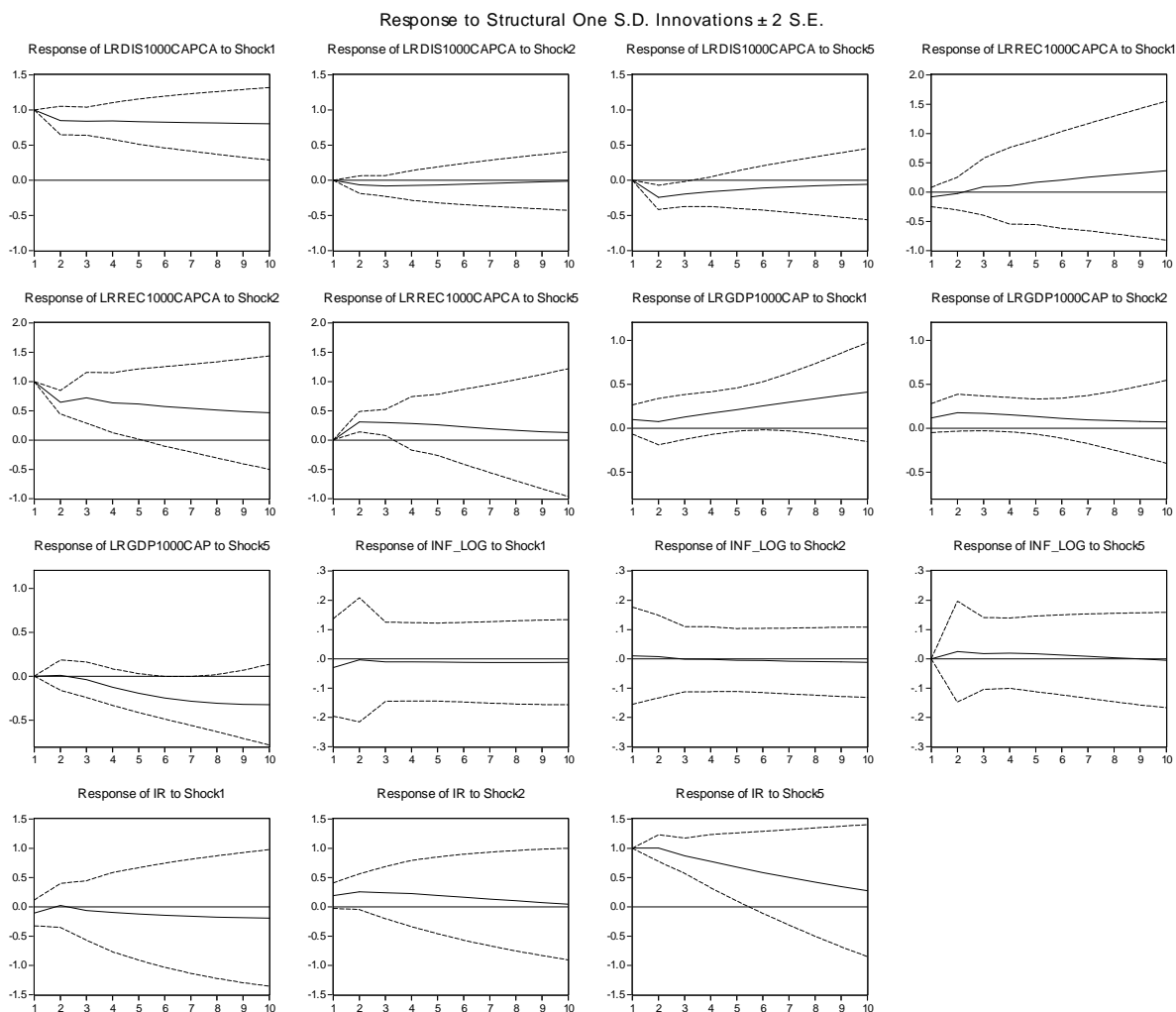


Shock 1 = Government spending shock  
 Shock 4 = Government receipts shock  
 Shock 5 = Monetary shock

Lrdis1000cap = Spending reaction  
 Lrrec1000cap = Receipts reaction  
 Lrgdp1000cap = Output reaction  
 Inf\_log = Inflation reaction  
 Ir = Interest rate reaction

## Appendix A continued

### My Restrictions (MR) - US data



Shock 1 = Government spending shock  
 Shock 2 = Government receipts shock  
 Shock 5 = Monetary shock

Lrdis1000capca = Spending reaction  
 Lrrec1000capca = Receipts reaction  
 Lrgdp1000cap = Output reaction  
 Inf\_log = Inflation reaction  
 Ir = Interest rate reaction

## Appendix B

Im, Pesaran, Shin test for unit root in panel data ( $H_0$ : all series are non-stationary) – p-values

|                    |                              |                         |                  |           |
|--------------------|------------------------------|-------------------------|------------------|-----------|
| Log GDP per capita | Log disbursements per capita | Log Receipts per capita | Interest rate    |           |
| 0.995              | 0.404                        | 0.174                   | 0.006*           |           |
| First Difference   | First Difference             | First Difference        | First Difference | Inflation |
| 0.000*             | 0.000*                       | 0.000                   | 0.000*           | 0.000*    |

\* indicates a series that is stationary

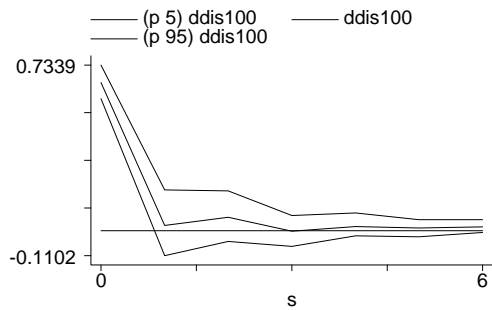
Dicky-Fuller Test for unit root by country: Interest Rate ( $H_0$ : series is non-stationary ) p-values

|                   |                   |                   |                   |
|-------------------|-------------------|-------------------|-------------------|
| Finland           | France            | Ireland           | The Netherlands   |
| 0.7169            | 0.7817            | 0.4347            | 0.6541            |
| First Differenced | First Differenced | First Differenced | First Differenced |
| 0.000*            | 0.000*            | 0.000*            | 0.000*            |

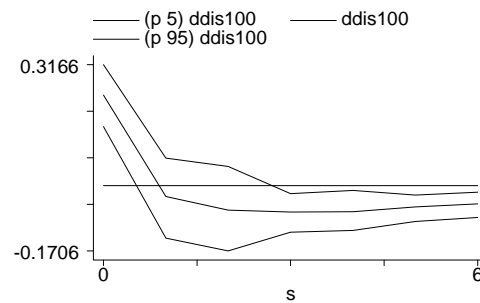
\* indicates a series that is stationary

## Appendix C – Impulse response functions for the whole sample

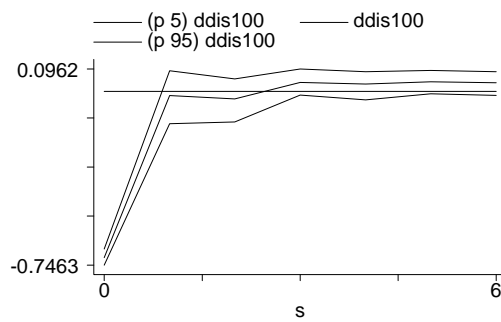
### Spending shock:



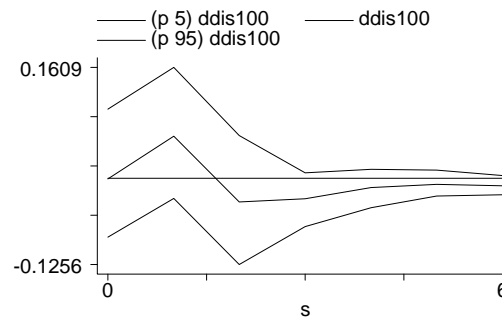
response of drec100 to ddis100 shock



response of dgdp100 to ddis100 shock

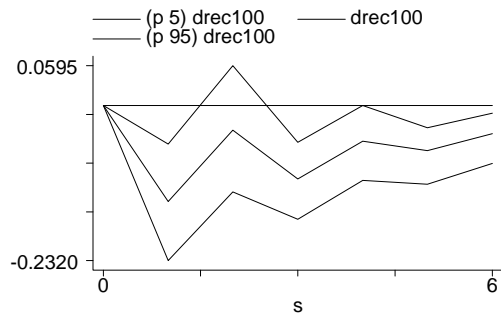


response of inf100 to ddis100 shock

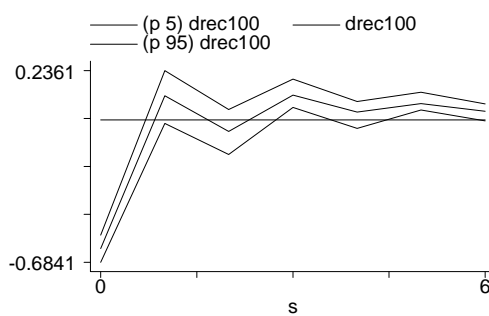


response of dir to ddis100 shock

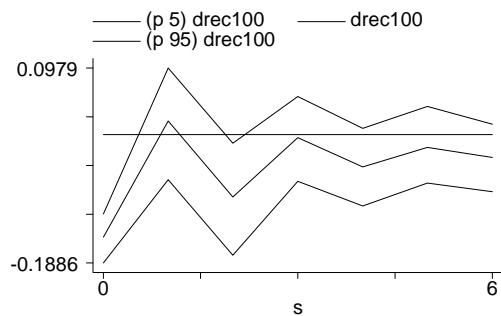
### Revenue shock:



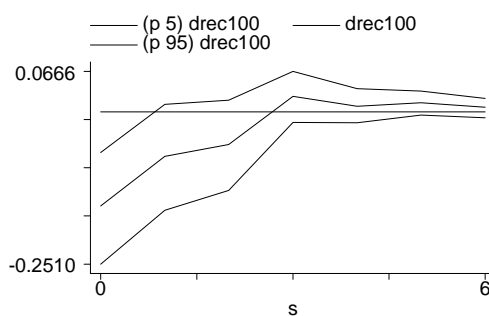
response of ddis100 to drec100 shock



response of dgdp100 to drec100 shock



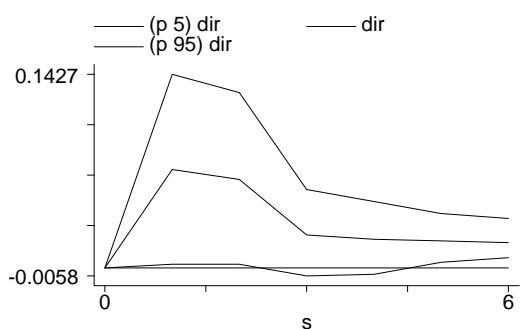
response of inf100 to drec100 shock



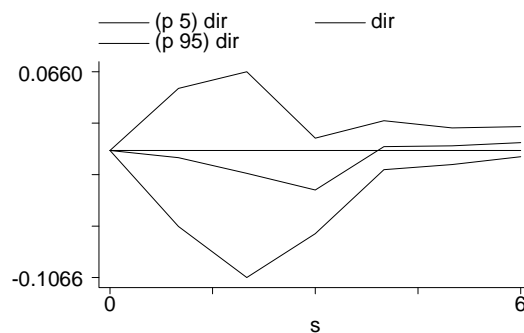
response of dir to drec100 shock

## Appendix C cont. – Impulse response functions for the whole sample

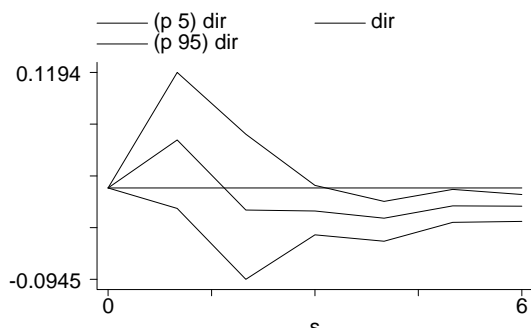
### Monetary Shock:



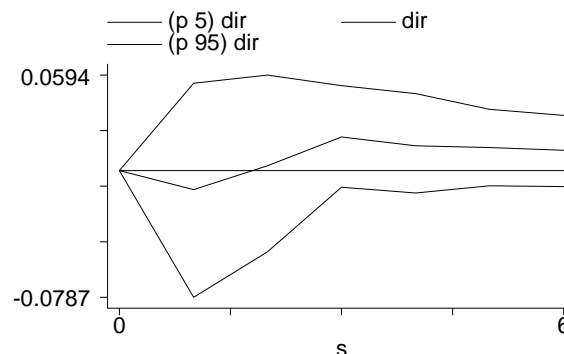
response of ddis100 to dir shock



response of drec100 to dir shock



response of dgdp100 to dir shock



response of inf100 to dir shock

ddis100 = Disbursements

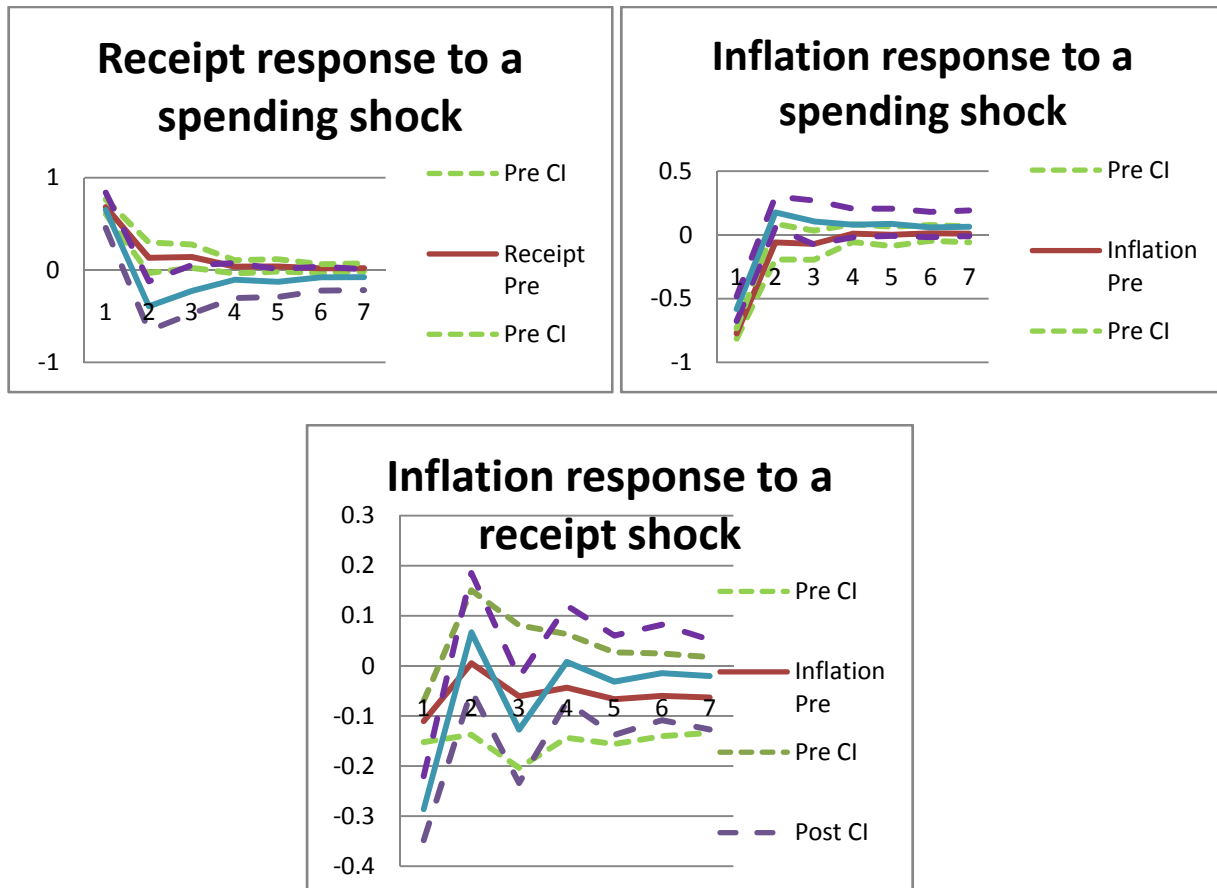
drec100 = Receipts

dgdp100 = GDP

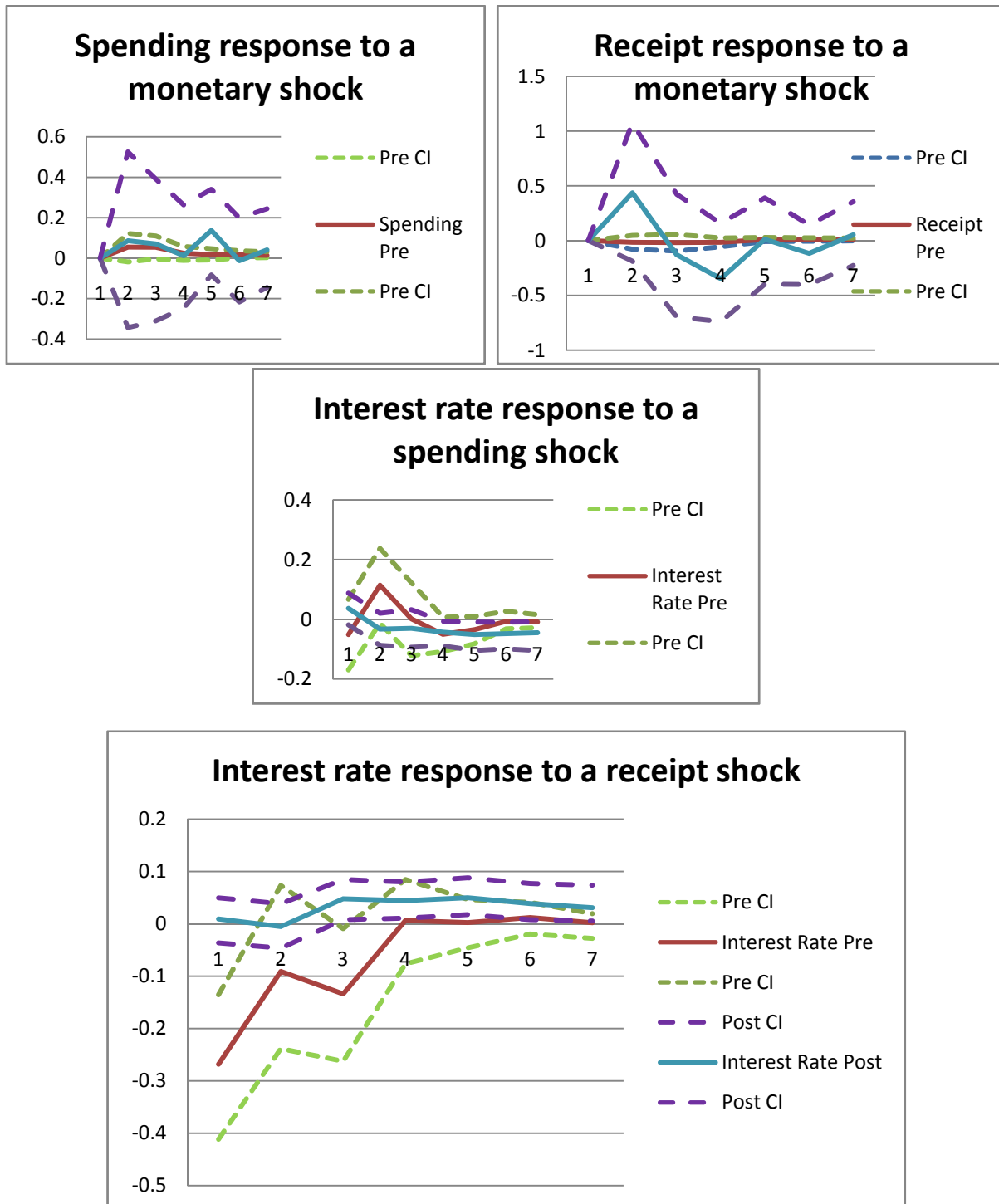
inf100 = Inflation

dir = Interest rates

## Appendix D – Difference in Impulse response functions pre- and post-EMU



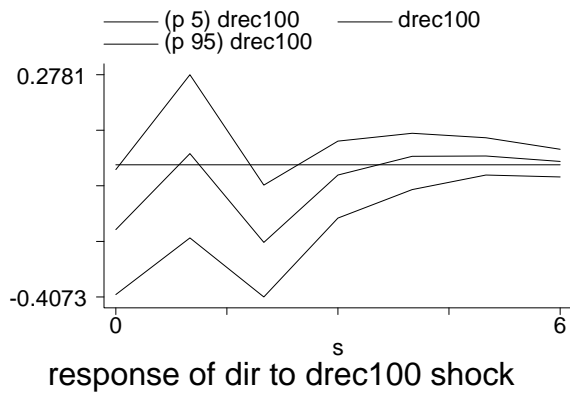
## Appendix E - Policy Interaction pre- and post-EMU



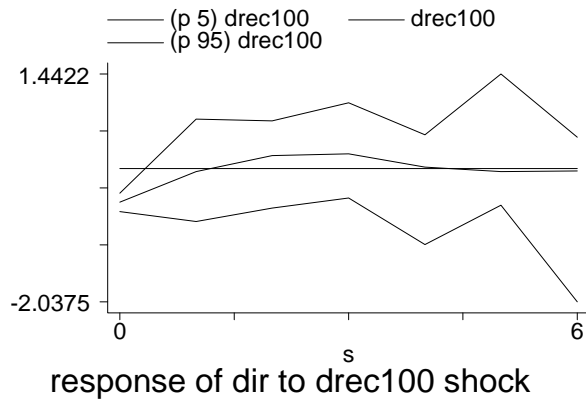


## Appendix F – The response of interest rates to receipt shocks over three periods.

### Pre-Maastricht (1980q1 – 1990q1)



### Maastricht (1990q1-1998q4)



### Post-Maastricht (1999q1 – 2006q4)

